

Exploring the emotional conflict task

Associations with clinical status and age

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Cognitive Neuroscience

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04.05.2015

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Exploring the emotional conflict task: associations with clinical status and age.

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Print: Reprosentralen, University of Oslo

Abstract

Objective. Cognitive impairment and difficulties in emotion regulation are proposed as a vulnerability factors in relation to a wide spectre of psychopathology. A close interplay between executive functioning (EF) and emotion regulation abilities has been emphasised, and development of standardised methods for research targeting emotion regulation difficulties in relation to EF dysfunction is imperative. An emotional conflict task is proposed to tap underlying EF factors in emotion regulation difficulties, potentially crossing diagnostic borders. So far, the task has only been used in a few clinical studies, and only with adult patients. Hence, its potential should be investigated within a broader range of disorders as well as age groups. **Method.** Existing data from three clinical studies (on Trauma, Continuous Fatigue Syndrome and Anorexia Nervosa) were combined in order to provide an exploration of the emotional conflict task in adolescents as well as in clinical populations not earlier targeted with this task. Furthermore, effects of emotion within the current task design were investigated with regards to age and clinical status for the first time. **Results.** No associations between clinical status and task-performance were found, but performance improved with age. The conflict adaptation effect (CAE), which the task is primarily designed for, did not emerge consistently across studies. Furthermore, effects of emotion related to age and clinical status were also found. **Conclusion.** Results indicate the tasks potential for investigating emotion-cognition interaction in normative development. However, concerns are raised with regards to the validity and utility of the CAE construct, and effects of emotion related to age and clinical status violate a basic assumption in the paradigm. These issues should be addressed and clarified in future studies, particularly if use of the task is to be expanded in clinical research and/or in developmental research.

Acknowledgements

My first thanks go to all the participants in the three clinical studies who contributed with their time and efforts for these data to be collected. In particular to those who are or have been ill, willing to expose themselves to testing in spite of the fact, so that knowledge of their condition can be gathered and potentially help others.

Thanks to Tor Endestad for suggesting the approach of focusing on an experimental task within my beloved subject of emotion regulation, allowing me to explore it across several existing data-sets. And Else-Marie Augusti; thank you for your generous supervision, patiently guiding me through the process of building the thesis and getting a proper grip on statistical analysis.

I would also like to thank the three lovely PhD students Ceclie Sol Skafnes, Laura Ann Wortinger and Lasse Bang for taking the time to provide me with data from their respective projects, clarifying question's concerning the data-files when needed and sharing ideas for different approaches.

Last but not least I would like to thank my husband Alexander and my daughter Kelly; this would not have been possible without your love and support.

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1 Introduction

1.1 Cognition and emotion regulation

Alongside the expansion of cognitive psychology, the idea that individual differences in cognition might underpin symptoms of psychological dysfunction has become a core premise shared by a wide spectrum of models related to various clinical conditions. For instance, individual differences related to executive functions (EF) like attention, cognitive flexibility, working memory and inhibition have been investigated, lending support for the notion of executive dysfunction as potential vulnerability factors in mood disorders as well as other diagnoses (Erk et al., 2010; Gross & John, 2003; Harrison, Sullivan, Tchanturia, & Treasure, 2010; Johnstone, van Reekum, Urry, Kalin, & Davidson, 2007; Martin & Alexeeva, 2010; O'Bryan, Mcleish, Kraemer, Fleming, & Bryan, 2014).

Difficulties in emotion regulation are also proposed as a vulnerability factor in relation to psychopathology. According to James J. Gross, emotion regulation refers to “shaping which emotions one has, when one has them, and how one experiences or expresses these emotions” (Gross, 2014, s.6). His well known “process model of emotion regulation” presents no less than five families of strategies (situation selection, situation modification, attentional deployment, cognitive change and response modulation), reflecting the vast diversity and complexity of the field (Gross, 1998). Some of the most studied emotion regulation strategies are related to his categories of attentional deployment (e.g. suppression or distraction) and cognitive change (e.g. cognitive reappraisal). This research indicates that emotion regulation might rely on overlapping cognitive functionality related to EF. More specifically, successful emotion regulation might depend on efficient deployment of top-down regulation of subcortical emotion-generative systems (Lee et al., 2012; McRae et al., 2010; Ochsner & Gross, 2008; Ochsner & Gross, 2005). This close interplay between EF and emotion regulation abilities is also emphasised by Dvir, Ford & Hill (2014) arguing that emotion regulation difficulties might play a role in most psychiatric disorders. Hence, studying EF *within* emotion regulation more directly might tap cognitive functions underpinning emotion regulation difficulties across strategies as well as clinical diagnosis. Such an approach could help to integrate clinical research currently differing widely in conceptualisation and assessment of emotion regulation (Berking & Wupperman, 2012). Hence, it is imperative to develop standardised methods for research and treatment targeting emotion regulation difficulties in relation to EF dysfunction.

1.2 Explicit and implicit emotion regulation

The majority of studies on emotion regulation have focused on explicit regulation (deliberate and effortful), using self-report questionnaires or instructions in the laboratory. Self-reports have their inherent caveats and it is hard to distinguish between regulatory attempts and their relative success (Berking & Wupperman, 2012). Furthermore, patients with mood disorders seem to perform equal to healthy controls in the laboratory when instructed to use specific strategies, compared to designs investigating spontaneous emotion regulation (Ehring, Tuschen-Caffier, Schnülle, Fischer, & Gross, 2010). Thus, emotion regulatory problems might relate to the lack of spontaneous use of adaptive strategies, rather than the ability to put them to use (Gruber, Harvey, & Gross, 2012). Methodological concerns and cognitive functionality underpinning emotion regulation taken together, suggests that studying underlying cognitive functionality in implicit emotion regulation might prove a fruitful approach. As a consequence, some authors argue for the usefulness of investigating implicit (automatic, preconscious) emotion regulation (Gyurak & Etkin, 2014). This approach could be particularly useful when searching for vulnerability factors across a variety of clinical groups, given its potential to tap underlying factors possibly expressed differently across different disorders.

The emotional conflict task is a recently developed paradigm for studying implicit emotion regulation. It is based on the classical Stroop Color Word task (Stroop CW) where subjects are presented with names of colours (words) printed in different colours (ink) (Stroop, 1935). The task is to name the ink-colour while ignoring the word. In congruent trials, ink and word match (e.g. the word “green” printed with green ink), whereas in incongruent they do not (e.g. the word “red” written in green). The “Stroop-effect” refers to the fact that incongruent trials produce longer reaction times (RT) compared to congruent trials. This is argued to be related to cognitive conflict arising between two similar, competing processing streams, calling for actively sustaining attention towards the task at hand (ink-colour), as well as inhibiting the highly automatic reading of words (Botvinick, Braver, Barch, Carter, & Cohen, 2001). In addition to the well-established stroop-effect the task is argued to tap cognitive adjustment to conflict through the investigation of trial-by trial sequences. This “conflict adaptation effect” (CAE) refers to the observed phenomena that incongruent trials following an incongruent trial yield faster RT’s compared to incongruent trials following a congruent trial (cI-iI: incongruent CAE). Congruent trials following a congruent trial also yield faster responses compared to congruent trials following an incongruent trial (iC-cC: congruent CAE). The “conflict-monitoring hypothesis” accounts for

the CAE by stating that distinguishable neural networks are implemented in detection of conflict versus the resolution of conflict (Botvinick et al., 2001). Upon conflict detection, cognitive control systems are alerted and subsequently engaged in conflict resolution through biasing information processing of task relevant stimuli (Egner & Hirsch, 2005a). Hence, CAE is thought to reflect the successful allocation of additional resources for cognitive control following detection of conflict in the previous trial (Botvinick, Nystrom, & Fissell, 1999; Carter & van Veen, 2007).

Building on this theoretical framework and the classical Stroop CW task, an emotional conflict task presents pictures of faces expressing various emotions with words describing different emotional states superimposed on them (Egner, Etkin, Gale, & Hirsch, 2008; Etkin, Egner, Peraza, Kandel, & Hirsch, 2006). Emotional conflict arise during incongruent trials, where word and facial expression do not match, producing a slowing of RT compared to congruent trials (Etkin, Egner, & Kalisch, 2011). Hence, the task can be used to investigate inhibition and adjustment of cognitive control during processing of emotional stimuli, providing an operationalization of implicit emotion regulation. Ochsner and Gross (2008) call for research on whether failure to recruit top-down resources for up- or down-regulation of emotion could be linked to emotion regulation difficulties in their review of neuroimaging studies of emotion regulation. The paradigm developed by Etkin et al. (2006) represents such an approach and could prove useful for understanding cognition-emotion interaction underlying difficulties in emotion regulation and psychopathology.

The tasks relevance to emotion regulation in psychopathology recently found support in a study reporting that adults diagnosed with generalized anxiety disorder (GAD) were unable to adapt to emotional conflict (Etkin et al., 2011). This finding was later supported in a second study reporting the same deficit in adult patients with GAD as well as patients with comorbid GAD and depression (Etkin & Schatzberg, 2011). However, it remains to be seen if the task is useful across a wider span of disorders. In order to investigate such a possibility, performance on the task should be assessed and compared across a wide array of disorders where emotion regulation difficulties are implied. Furthermore, the task has only been used with adult participants, and the tasks potential for investigating implicit emotion regulation in younger populations should be addressed as well.

1.3 Implicit emotion regulation in adolescents

Important considerations regarding the use of this task with younger participants are prompted by its dependence on highly developed cognitive control functions in frontal

regions (Botvinick, Cohen & Carter, 2004; Carter & van Veen, 2007; Fan, Flombaum, McCandliss, Thomas & Posner, 2002). Significant improvements in processing speed and intellectual functioning are seen throughout late childhood and adolescence, particularly in the development of EF (Anderson, 1998; Rosso, Young, Femia, & Yurgelun-Todd, 2004; Rubia et al., 2000). Furthermore, maturation of the prefrontal cortex continues into late adolescence/early adulthood (Sowell, Thompson, Holmes, Jernigan, & Toga, 1999; Yurgelun-Todd, 2007). Since the task relies on frontal regions implicated in regulatory control it could reflect changes in emotion regulation efficiency related to frontal lobe maturation. Hence, the task might help inform us of changes in emotion regulation related to age and normative development during adolescence.

The transitional phase from childhood to adulthood begins with the physical changes of sexual maturation in puberty and stretch until the assumption of an independent, adult life. It is a period marked by substantial changes in physical appearance as well as changes in cognition, behaviour and emotional processing (Casey, Jones, & Hare, 2008). Some of the developmental changes during adolescence makes it a time of vulnerability, evident in observed increase in affective disorder onset (Steinberg, 2005). A tendency towards more risky behaviour like drug-abuse, consumption of illegal substances, engaging in unprotected sex, drunken driving and carrying weapons further adds to this vulnerability (Eaton et al., 2006; Kelley, Schochet, & Landry, 2004; Silveri, Tzilos, Pimentel, & Yurgelun-Todd, 2004). More risky behaviour and emotional reactivity have been explained by the slow maturation in frontal regions related to top-down regulatory control (Yurgelun-Todd, 2007). More recently, several authors have argued for a new model, providing an explanation for the relative increase of this behaviour in relation to adults as well as earlier childhood (Casey et al., 2010, 2008; Steinberg, 2005). These authors argue, that the linear development of cognitive control cannot explain this non-linear increase in recklessness and reactivity. They propose a model where maturation of affect-generating regions in the brain peak earlier than regions implicated in cognitive control. These different developmental trajectories create an imbalance between affect generation and regulatory control, explaining behavioural and emotional changes observed during adolescence. Consequently, it has been argued that in order to understand how brain maturation during adolescent affects social and emotional changes, it is necessary to study cognition and emotion interaction (Keating, 2004, s.67). The emotional conflict task provides an operationalization for this aim since the task indicates the relative efficiency of cognitive control within emotion regulation. Hence, this task could aid

understanding of why this developmental period is a time of vulnerability with increased risk for the onset of emotional and behavioural problems.

1.4 Background for the present thesis

Three research projects at the University of Oslo investigating post traumatic stress disorder (PTSD) and continues fatigue syndrome (CFS) in adolescence as well as anorexia nervosa (AN) in adults (recovered females) respectively, have included a version of the emotional stroop task developed by Etkin and colleagues (Etkin et al., 2006). Combined, these studies provide an opportunity to investigate implicit emotion regulation within a large age-span, stretching from adolescence to adulthood as well as within clinical populations not yet targeted with this paradigm.

Posttraumatic stress disorder (PTSD) is an anxiety disorder following exposure to a traumatic event. Core symptoms of PTSD include disturbing recurring flashbacks, avoidance/numbing and hyper arousal continuing for more than a month after the occurrence of a traumatic event (APA, 2013). In order to understand why some people exposed to trauma develop PTSD, while others recover from trauma without long-term consequences, factors related to cognitive functioning have been studied. Attentional deployment, inhibition and memory are main focus areas in this research (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Bar-Haim, 2010; Cisler et al., 2011; Fleurkens, Rinck, & van Minnen, 2011; Iacoviello et al., 2014; for a review: Hayes, Vanelzakker, & Shin, 2012;) as well as in PTSD theory (Banich et al., 2009; Brewin, Dalgleish, & Joseph, 1996; Brewin & Holmes, 2003; Ehlers & Clark, 2000). For instance; it has been suggested that early, automatic attentional bias (AB) towards threat might play a role in the development and maintenance of PTSD (Bar-Haim et al., 2007; Bar-Haim, 2010) and that top down control of attention moderates this relationship (Bardeen & Orcutt, 2011; Bardeen & Read, 2010; Schoorl, Putman, Van Der Werff & Van Der Does, 2014). Importantly, using the Stroop CW task, impaired interference control has been found to predict intrusive cognition like re-experiencing in PTSD (Kertzman, Avital, Weizman, & Segal, 2014).

Furthermore, studies have documented maladaptive emotion regulation in PTSD when investigating explicit emotion regulation like suppression and avoidance (Aikins et al., 2009; Dunmore, Clark, & Ehlers, 2001; Wenzlaff & Wegner, 2000). Difficulties in accessing efficient emotion regulation have also been found to predict DSM-V symptom clusters (O'Bryan et al., 2014) and PTSD participants in a fMRI study showed reduced activity

compared to controls in regions implicated in top-down regulatory control during an instructed emotion regulation task (New et al., 2009). However, studies of implicit emotion regulation in PTSD are lacking, and no published study has yet investigated implicit emotion regulation in PTSD using the paradigm developed by Etkin and colleagues (Etkin et al., 2006). Given the severe long-term consequences of PTSD, in tandem with heightened vulnerability during adolescence, broadening our knowledge of how implicit emotion regulation might put youth at risk for developing PTSD is particularly important.

Addressing young populations with regards to chronic fatigue syndrome (CFS) is important as well, since children and adolescents seem to recover more rapidly than adults (Afari & Buchwald, 2003; Krilov, Fisher, Friedman, Reitman, & Mandel, 1998) and should be targeted for efficient treatment. Furthermore, investigating CFS in adolescence might limit confound related to chronicity. CFS is characterized by severe, unexplained and disabling fatigue lasting for at least 6 months, does not reduce with rest, and is accompanied by symptoms such as musculoskeletal pain, impaired memory and concentration, headache and sleep problems (Fukuda, Straus, Hickie, Sharpe, Dobbins, 1994). The aetiology of CFS is not well understood, but findings suggests that physiological and psychological factors interact to predispose individuals as well as maintain symptoms (Afari & Buchwald, 2003). The high prevalence of self-reported problems with memory and concentration has prompted research on cognitive functioning in CFS using various cognitive tests. A recent meta-analysis found reaction time (RT), attention and memory to be areas of potential impairment in CFS (Cockshell & Mathias, 2010). Some of the studies in this meta-analysis employed a Stroop task, indicating reduces processing speed in CFS, but no support for impaired interference control (Fuentes, Hunter, Strauss, & Hultsch, 2001; Mahurin et al., 2004; Metzger & Denney, 2002).

Difficulties in processing of emotional stimuli in CFS have been addressed in a few studies, finding evidence for problems with identifying feelings (Sepede et al., 2011; van de Putte, Engelbert, Kuis, Kimpfen, & Uiterwaal, 2007) and tolerating distress (Hambrook et al., 2011). Regarding difficulties in emotion regulation and emotion-cognition interaction in CFS, research is currently silent. This seems surprising given high rates of comorbidity with anxiety and depression (Lievesley, Rimes, & Chalder, 2014), indicating emotional dysfunction in CFS. Furthermore, comorbid depression has been shown to significantly increase level of psychophysical distress in CFS (Sepede et al., 2011), underscoring the need to address emotion regulation in this disorder. Furthermore, possible cognitive and emotional

impairments combined indicate a need to investigate cognitive factors in emotion regulation in CFS. Given the severe disabling character and long term life-consequences of CFS together with the limited understanding of its aetiology, research to shed light on emotion-cognition interaction in CFS should be conducted.

Contrary to the somewhat limited knowledge about cognitive deficits in CFS, evidence of difficulties on a range of cognitive variables like attention, memory and executive functioning in AN is building (Gulliksen, 2014; Hatch et al., 2010; Oldershaw et al., 2011; Tchanturia, Campbell, Morris, & Treasure, 2005). AN is an eating disorder marked by radical eating restrictions, maladaptive eating habits and rituals, body-weight obsession as well as strong fear of body-weight gain (Haynos & Fruzzetti, 2011; Oldershaw et al., 2011) (APA, 2013). Cognitive biases influencing how patients process, evaluate and think of their body as well as food-related stimuli are thought to play an important role in AN (Aspen, Darcy, & Lock, 2013; Brooks, Prince, Stahl, Campbell, & Treasure, 2011; Johansson, Ghaderi, & Andersson, 2005; Zhu et al., 2012). However, whether such attentional biases pose a risk factor, or develop as a result of the disorder is less clear (Gulliksen, 2014; Oldershaw et al., 2011). The ability to inhibit non-disorder salient distractors might provide a clue. Unfortunately, few studies have directed attention towards interference tapping underlying vulnerability related to inhibition. One notable exception, implementing the CW stroop task, found no differences in performance in adolescents with AN compared to controls either before or after weight gain (Lozano-Serra, Andrés-Perpiña, Lázaro-García, & Castro-Fornieles, 2014). Impairments in cognitive flexibility on the other hand, is thought to predate the development of AN and persist after recovery (Holliday, Tchanturia, Landau, Collier, & Treasure, 2005; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007). Thus, set-shifting has been suggested as an endophenotype in AN, independent of malnutrition.

Difficulties with emotional (Hatch et al., 2010) and social functioning (Zucker et al., 2007) in AN are also thought to play an important role in the development and maintenance of symptoms (Oldershaw et al., 2011). Social anxiety and social phobia are common comorbid disorders in AN, further attesting to emotional difficulties (Godart, Flament, Lecrubier, & Jeammet, 2000; Kaye, Bulik, Thornton, Barbarich, & Masters, 2004). According to Haynos & Fruzzetti (2011), the role of emotion and emotion dysregulation are controversial in AN and is lacking in research, in spite of its place in theory and research in other ED's (e.g.; bulimia) (Gilboa-schechtman, Avnon, Zubery & Jeczmiern, 2006). However, heightened reactivity (Haynos & Fruzzetti, 2011) and low emotional tolerance (Federici &

Kaplan, 2008; Hambrook et al., 2011) as well as reduced emotional awareness (Gilboa-schechtman et al., 2006; Hambrook et al., 2011) have been found in AN. In fact, some authors theorise that disorder-related behaviour (e.g.; eating restriction, excessive training) might actually serve as emotion regulation strategies (albeit dysfunctional) for AN patients (Engel et al., 2005; Haynos & Fruzzetti, 2011). Other maladaptive emotion regulation strategies like extensive suppression (Geller, Cockell, Hewitt, Goldner, & Flett, 1999) and rumination (Nolen-hoeksema, Wisco, & Lyubomirsky, 2015) are also indicated in AN. Why these strategies are utilised above other, more adaptive strategies, or whether this might be related to cognitive factors, are less clear. Given the indications of cognitive anomalies and frequent use of maladaptive emotion regulation strategies in AN, enhancing our understanding of implicit emotion regulation in AN is important. The fact that AN is very difficult to treat (Haynos & Fruzzetti, 2011) and has the highest mortality rate of psychiatric disorders (Sullivan, 1995) further underscores the importance of gaining more knowledge of emotion and cognition interaction in AN.

1.5 The aim of the present thesis

Given implications of cognitive as well as emotional deficits in PTSD, CFS and AN, broadening our understanding of implicit emotion regulation in these disorders is called for. Addressing this need, three separate studies on PTSD, CFS and AN respectively, implemented the emotional conflict paradigm developed by Etkin et al. (2006). Jointly these studies offer the possibility for a broader exploration of this task across clinical populations not previously investigated with the current paradigm. Furthermore, implicit emotion regulation is somewhat understudied in these diagnoses, and comparing performance across clinical diagnoses with this task might shed light on potential differences in the way deficient top-down regulation of emotion are expressed across different diagnosis.

A recent fMRI study used this task to investigate emotional conflict (EC; incongruent minus congruent trials) and conflict adaptation (CAE) in anxiety (Etkin, Prater, Hoeft, Menon, & Schatzberg, 2010). Patients diagnosed with anxiety performed equal to healthy controls on EC, but failed to adapt to conflict. Incongruent CAE (cI-iI) emerged for healthy controls, but were not present in the anxiety group. Attesting to the specificity of the deficit (adapting to conflict), the two groups performed equal on congruent CAE (iC-cC) (Etkin et al., 2010).

Difficulties with emotion regulation are well documented and theorized within anxiety (Campbell-Sills, Ellard & Barlow, 2014) as well as PTSD (Aikins et al., 2009;

O'Bryan et al., 2014; Wenzlaff & Wegner, 2000). Hence, results for PTSD on EC and CAE could be expected to express themselves along the line of those found in the study by Etkin et al., (2010). However, a study using the CW Stroop task found that increased interference was related to PTSD symptoms (Kertzman et al., 2014), and the emotional conflict task has been shown to present stronger interference compared to a non-emotional version (Egner et al., 2008). Thus, PTSD patients might also show more pronounced interference compared to controls on EC.

With regards to AN, poor cognitive flexibility (Holliday et al., 2005; Roberts et al., 2007) could influence the ability to adapt to conflict in the current paradigm. Furthermore, anxiety often occurs as comorbid disorder in AN (Godart et al., 2000; Kaye et al., 2004). Taken together, AN patients could be expected to deviate from healthy controls on CAE. Interference is less studied in AN, making performance on EC somewhat harder to predict. However, one study implementing the CW stroop task found no group differences on this measure in adolescence (Lozano-Serra et al., 2014), indicating that AN patients might perform equal to healthy controls on EC.

This might be the case for CFS patients as well. Earlier results on Stroop tasks indicate slower processing speed, but no difference in interference control for CFS patients (Fuentes et al., 2001; Mahurin et al., 2004; Metzger & Denney, 2002). Furthermore, a recent study of cognitive functioning in CFS also suggests an overall slower processing time rather than impairment in top-down regulatory control (Cockshell & Mathias, 2013). Accordingly, longer overall RT rather than deviations related to EC or CAE compared to controls could be expected for this group.

The three studies represent a large age-span in addition to clinical diversity (mean ages; CFS=16,6; PTSD=20,5; AN-recovered=27). Increased interference has been found in adolescents compared to adults (Ladouceur et al., 2009), and EC as well as CAE are thought to depend highly on frontal regions, not fully matured in adolescents (Sowell et al., 1999; Yurgelun-Todd, 2007). Hence, performance on these variables in relation to age could inform us of changes in top-down regulation of emotion in normative development. Specifically, performance on RT, EC and CAE could be expected to improve with age.

Given the novelty of using this task on adolescents, the variable of intraindividual variability in reaction time (IIV), useful in examination of basic issues in development (Williams, Hultsch, Strauss, Hunter, & Tannock, 2005), could be explored as well. For instance; IIV has been investigated as a potential marker of failure in top-down regulatory

control of attention in ADHD (Denney, Rapport, & Chung, 2005; Hervey et al., 2006; Karalunas, Geurts, Konrad, Bender, & Nigg, 2014; Lin, Hwang-Gu, & Gau, 2015) brain lesions and schizophrenia (MacDonald, Nyberg, & Bäckman, 2006). Furthermore, IIV have been found to predict negative affectivity (Ode, Robinson, & Hanson, 2011), indicating its relevance to emotional processing. Importantly, some authors argue that IIV might provide a more precise measure than central tendencies data like RT and error rates (Hervey et al., 2006a; Kofler et al., 2013), and IIV generally show larger effect sizes for children and adolescents compared to adults (Kofler et al., 2013). Hence, this variable might be more sensitive than RT, EC and CAE, particularly for the younger participants.

An important premise within the paradigm presented alongside it, is that the emotional content of the stimuli is not driving any effects, since no significant effects of emotional content (face or word) were found (Etkin et al., 2006). However, this conclusion is based on how a healthy adult sample performed the task. Given the heightened reactivity observed in adolescence (Casey et al., 2008; Steinberg, 2005) as well as attentional bias towards threat-related stimuli implicated in several psychological disorders (Bar-Haim et al., 2007; Bardeen & Orcutt, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007; Harrison, Tchanturia, & Treasure, 2010), processing of emotional stimuli within this paradigm might deviate in clinical groups and adolescents as compared to healthy adults. In other words, effects of emotions related to both age and diagnostic status could be present, and the premise of emotion not driving any effects in the current paradigm should therefore be tested more thoroughly. Two of the current studies were investigating adolescents, and threat-related attentional bias has been observed in PTSD and AN (Bar-Haim et al., 2007; Harrison et al., 2010). Hence, the current combination of studies allow for further examination of potential effects driven by emotional content within the paradigm.

The aim of the current paper then, is to provide a fairly broad exploration of the emotional conflict task. The approach to this exploration is threefold. First; to investigate and compare implicit emotion regulation in PTSD, CFS and AN, disorders not previously investigated with this task. Second; examine task performance within a developmental perspective, since earlier studies have used this task on adult populations only. And third; test whether the underlying assumption that no effects are driven by emotional content in the task still holds when adolescents and/or clinical participants perform the task.

Based on earlier findings of cognitive and emotional dysfunction in PTSD, CFS and AN, the following hypothesis were formulated; 1) EC was expected to be elevated for the PTSD (but not CFS or RAN) test-group compared to controls. 2) PTSD and RAN (but not CFS) test groups were expected to show reduced (or no) incongruent CAE compared to healthy controls. No group differences on congruent CAE compared to healthy controls were expected. 3) RT was expected to be longer overall for the CFS test-group (but not PTSD or RAN) compared to healthy controls. 4) RT, EC, and IIV were expected to show a negative correlation with age. CAE were also expected to relate to age, expressed as larger negative values for older individuals compared to younger. 5) Based on findings related to effects of emotion observed in youth and several clinical disorders, effects of emotion related to age and clinical status were expected to be present.

2 Method

All three studies employed the same experimental paradigm developed by Etkin et al. (2006), with only minimal differences related to stimuli-presentation. However, the studies differ substantially with regards to participant-populations, research questions and overall study design. Given the differences across studies, participants and questionnaires from each study will be described first, followed by a closer description of the experimental paradigm they all share.

2.1 Study 1: TRAUMA

2.1.1 Participants.

The TRAUMA study investigated a group of individuals exposed to a violent traumatic event during a political gathering on the Island of Utøya in 2011. 37 Norwegian adolescents were recruited through support groups and the legal counsellor for Utøya-victims. 28 of these participated in the study. One participant failed to show for testing, two participants were excluded due to technical errors and failure to perform the emotional conflict task and two because of high age, leaving a sample of 23 individuals (mean age = 20.95 ± 2.65) in the trauma group. 5 participants (21,7%) met diagnostic criteria for PTSD, whereas 17 did not (one participant had missing clinical data). Out of 27 non-exposed, matched controls, 3 participants were excluded due to clinical scores on PTSD (2) and failure to show for testing (1). The final control group then consisted of 24 individuals (mean age = 21.57 ± 3.12).

2.1.2 Questionnaires.

Post Traumatic Checklist Civilian version (PCL-C; Weathers, Litz, Herman, Huska & Keane, 1996). The PCL-C is a frequently used self-report questionnaire with 17 questions related to the 17 symptoms described in the PTSD criteria in DSM-IV. A validated Norwegian version, approved by the authors of the original measure, were used (Hem, Hussain, Wentzel-Larsen, & Heir, 2012).

2.2 Study 2: CFS

2.2.1 Participants.

For the NorCAPITAL CFS study a total of 120 adolescents were enrolled through The Department of Paediatrics at Oslo University Hospital, a national referral centre in Norway for young patients with CFS. A broad case definition, based on a minimum of 18

weeks of unexplained, disabling, chronic/relapsing fatigue of new onset was employed as the main inclusion criteria, in line with clinical guidelines (Royal College of Paediatrics and Child Health, 2004; National Institute for Health and Clinical Excellence, 2007). A second inclusion-criteria was defined as functional disability resulting from fatigue to a degree that prevented normal school attendance. No other symptom criteria were required. This is at odds with guidelines from the frequently used International Chronic Fatigue Syndrome Study Group at the Centers for Disease Control and Prevention (Fukuda et al., 1994). However, validity for these guidelines has not been well established, and validity concerns have been raised with regards to adolescents in particular (Nisenbaum, Reyes, Unger, & Reeves, 2004; Sullivan, Pedersen, Jacks & Evengård, 2005; Wyller & Helland, 2013). The Referral procedures was constructed so as to confirm that patient did not have 1) any other medical or psychiatric disorder 2) experienced concurrent demanding life event, which might explain the long lasting fatigue 3) or used pharmaceuticals regularly. A subset of 20 CFS patients (mean age=15.7 ± 1.8) and 34 matched healthy controls (mean age=15.2 ± 1.7) recruited from local schools, were enrolled in the part of the study involving the emotional conflict paradigm.

2.2.2 Questionnaires.

The Chalder Fatigue Questionnaire (CFQ; Chalder, Berelowitz, Pawlikowska et al., 1993). CFQ is a frequently used outcome measure in CFS research. It is regarded a valid measure among adults (Fukuda et al., 1994; White et al., 2011) as well as adolescents (Godfrey et al., 2009). It contains 11 questions, answered on a 0-3 likert scale. Total sum score range from 0 to 33, with higher scores implying more severe fatigue.

The Functional Disability Inventory (FDI; Walker & Greene, 1991) is a global measure of children's and adolescent's physical and psychosocial functioning. FDI has been extensively validated, is considered sensitive for changes over time and has been found useful in adolescent CFS (Claar & Walker, 2006; Robyn Lewis Claar & Walker, 2006; Kashikar-Zuck et al., 2011). The measure is comprised of 15 items, each scored on a 0-4 likert scale. Total range is from 0 to 60, where higher scores imply more severe disability.

2.3 Study 3: RAN

2.3.1 Participants.

For the third study 23 female recovered anorexia nervosa participants (mean age=27,3 ± 5,0) were recruited through online advertisement and IKS (Interessegrupper for kvinner med spiseforstyrrelser; the national user organisation for women with eating disorders). Inclusion criteria were a minimum of one episode fulfilling criteria for AN in DSM-V (APA, 2013) as

well as currently being recovered for a minimum of 12 months. Being recovered was defined by absence of ED-related behaviour (e.g., bulimic episodes, excessive training and extreme restrictive eating) and remaining body-weight (above 18 in Body Mass Index). Exclusion criteria's included 1) currently meeting criteria for any DSM-IV axis 1 disorders, 2) having a prior history of schizophrenia or bipolar disorder and 3) substance abuse. Females matched for age and education were enrolled in the control group (mean age=26 ± 4,7) through advertisement.

2.3.2 Questionnaires.

The eating disorders examination-questionnaire (EDE-Q; Fairburn & Beglin, 1994; Rø, Reas, & Lask, 2010). EDE-Q is a widely used self-report questionnaire assessing attitudes and behaviours in eating disorder () for clinical as well as community samples. Questions are focused around the previous 28 days, with answers on a likert scale from 0-6 indicating the frequency of disorder related behaviour and thoughts throw-out this period. A validated Norwegian translation of the EDE-Q was used for the current study.

2.4 Experimental paradigm

The emotional conflict task was designed in close resemblance to the paradigm developed by Etkin and colleagues (Egner et al., 2008; Etkin et al., 2006). A total of 168 trials presented a monochromatic photograph of either a happy or fearful face (7 male and 7 female) from the Karolinska database (Lundqvist, 1998). The word "FEAR" or "HAPPY" was superimposed on each picture, creating four conditions: congruent and incongruent fearful face as well as congruent and incongruent happy face. Subjects were instructed to ignore the word, and to indicate the emotional expression of the actor as fast and accurately as possible by pressing a button using the right index and middle finger. E-prime 2.0 Software (Psychology Software Tools, Pittsburgh, PA) was used to develop and present the stimuli sequence. Trials lasted for 1000 ms, (with random intervals ranging from 3000 to 5000, mean = 4000), appearing in a pseudorandom order, counterbalanced across gender, actor, facial expression, and word.

Table 1. Demographic and clinical characteristics of all test groups and healthy controls

Characteristics	Test group		Control group		
Study 1 (TRAUMA)	N	Female	N	Female	
Participants	23	36,4 %	23	52,2 %	
PTSD diagnose	5 (21,7%)		0		
	Mean	SD	Mean	SD	P
Age (years)	20.95	2.65	21.57	3.12	0.483
PCL-C	0.709	0.968	-0.749	0.243	0.000*
Study 2 (CFS)	N	Female	N	Female	
Participants	20	85 %	34	72,7%	
CFS diagnose	20 (100%)		0		
	Mean	SD	Mean	SD	P
Age (years)	15.7	1.8	15.2	1.7	0.310
Fatigue	0.903	0.932	-0.536	0.558	0.000*
Functionality	1.117	0.798	-0.663	0.156	0.000*
Study 3 (RAN)	N	Female	N	Female	
Participants	23	100%	21	100%	
AN diagnose	0		0		
	Mean	SD	Mean	SD	P
Age (years)	27,3	5,0	26	4,7	0.381
EDE-Q	0.469	1.183	-0.514	0.281	0.001*

Note. PCL-C (Post Traumatic Checklist Civilian version), Fatigue (The Chalder Fatigue Questionnaire), Functionality (The Functional Disability Inventory) and EDE-Q (The eating disorder examination-questionnaire). * Significant group difference.

Table 2. Demographic and clinical characteristics for the pooled test – and control groups.

Characteristics	Pooled test group		Pooled control group		P
	N	Female	N	Female	
Participants	65	48 (73.8 %)	77	57 (74 %)	0.981
Clinical diagnose	25 (38,5 %)		0 (0%)		0.000*
	Mean	SD	Mean	SD	
Age (years)	21.57	5.9	20.06	5.512	0.119
Clinical score	0.705	989	-0.610	0.304	0.000*

Note. Clinical diagnose (number of participants meeting diagnostic criteria) was compared using a chi-square test for independence ($\chi^2 (1, n = 145) = 36, p = .000, \phi = 0.516$).

* Significant group difference between pooled test group and pooled control group.

2.5 Analysis

Variables were based on reaction time data. Previously, results on error-rates have reflected those of reaction time with this task (Etkin et al., 2006). Due to the limited scope of the current thesis error rates were therefore excluded from analysis. Reaction time data were analysed using SPSS version 20 (SPSS, Inc., Chicago, IL). More specifically the following dependent variables were investigated: 1) overall mean reaction time (RT), 2) mean RT of

incongruent trials minus mean RT of congruent trials (EC), 3) standard deviation (IIV), 4) postincongruent incongruent trials minus postcongruent incongruent trials (iI-cI: incongruent CAE) and 5) postcongruent congruent trials minus postincongruent congruent trial (cC-iC: congruent CAE).

One-way analysis of variance was conducted to compare test groups with controls in two steps, entering variables of interest (RT, EC, IIV and CAE) as dependent variables and group as factor. In the first step analysis was performed to compare test groups with controls from the same study (ANOVAs). Second, in order to create a large control group and avoid a type II error, controls across all studies were pooled and used for comparison with each test-group. Given the large age span, analysis of covariance (ANCOVAs) was performed comparing test groups with the pooled control-group while entering age as covariate.

Furthermore, to investigate changes in performance on the emotional stroop task related to normative development, controls from the three studies were entered as age groups (factor) in a one-way ANOVA, comparing young adolescent (study 2), old adolescent (study 1) and adults (study 3) on dependent variables.

In order to investigate potential effects of emotion (facial expression) in the current design, a factorial 2 (fearful versus happy face) x 2 (congruent versus incongruent) repeated measures (MANCOVA) was also performed on the pooled control group and the pooled test group respectively, entering age as covariate.

3 Results

3.1 Preliminary analysis

Outliers were removed based on fixed values ($2500 > < 250$ ms), and all error as well as post error trials were removed in accordance with the paradigm as described by Etkin and colleagues (Etkin et al., 2006). One subject (from the control group of study 1) was excluded due to excessive numbers of errors (95 %).

As presented in table 1 no significant differences were found between age or gender between test group and control group within each study. A one way analysis of variance (ANOVA) entering age as dependent variable and the three studies as factor, confirmed the expected significant difference of age between studies; $F(2, 139) = 139.240, p < .000$. Age was therefore controlled for when comparing test-groups to the pooled control-group. Furthermore, significant differences in sex distribution across studies were found using independent t-tests: $t(96) = -3.523, p = .000$ (study 1 and 2), $t(95) = -3.551, p = .000$ (study 2 and 3) and $t(87) = -7.332, p = .000$ (study 1 and 3). Given this uneven distribution, sex-differences on all variables were tested within the TRAUMA study having approximately equal numbers of male and female participants. Results indicated no sex-differences on any variables. Additionally, a significant difference in frequency of diagnosed participants was found between test-groups when performing a chi-square test of independence; $\chi^2(2, n=67) = 50.9, p = .000, \phi = 0.872$.

One sample t-tests were performed to investigate the presence of EC and CAE in all three studies. EC is generally expected to appear for healthy individuals as well as for clinical participants. Group differences are therefore expected with regards to the relative size of the effect. CAE on the other hand is expected to appear in healthy individuals, but to be absent in clinical groups having difficulties adapting to conflict. Hence, the presence of EC was tested on all participants in each study, whereas the presence of CAE was tested on control groups and test groups separately. Due to multiple t-tests (3 pr. study), Bonferroni correction was performed ($p < .05$ divided by 3), providing a more conservative significance level; $p < .017$. EC produced a slowing in RT as expected, with incongruent trials showing significantly longer RT compared to congruent trials in all three studies; study 1; $t(45) = 7.035, p < .000$, study 2; $t(55) = 5.103, p < .000$ and study 3; $t(43) = 9.762, p < .000$. Contrary to expectations, the presence of a detectable incongruent CAE did not emerge in any of the control groups; study 1; $t(22) = -1.535, p = .139$, study 2; $t(33) = -1.994, p = .054$ and study 3; $t(20) = 1.188, p = .249$. With the exception of study 2; $t(33) = -3.746, p = .001$, this lack of effect was repeated for congruent CAE; study 1; $t(22) = -.927, p = .364$, and study 3; t

(20) = 1.917, $p = .70$. In order to examine whether a lack of power (small N) in each study caused this inconsistency, the presence of CAE was investigated using the pooled control group. Bonferroni correction was performed due to multiple t-tests ($p < .05$ divided by 2), providing a significance level of $p < .025$. Incongruent CAE was not present in the pooled control-group either; $t(77) = 1.779$, $p = .079$, but congruent CAE was found to be significantly different from zero; $t(77) = -2.439$, $p = .017$. The presence of CAE was then tested in all test-groups. Nor incongruent or congruent CAE appeared in any of the test-groups either.

Hence, analysis of potential group differences on CAE was only reported for studies where an effect was present in the control group (study 2). Furthermore, no analysis comparing test-groups to the pooled control-group was performed for the CAE effects, given the inconsistency/lack of presence of the effect in healthy controls as well as test groups across studies.

3.2 Group differences

One-way analyses of variance (ANOVA) comparing test-groups to healthy (within-study) controls did not show any significant group differences in any of the studies for RT, EC, IIV or congruent CAE (see table 3). Pooling controls, entering age as covariate, did not reveal significant difference between test-groups and healthy controls either (see table 4).

Table 3. Group differences on variables using within study-controls.

Study 1 (TRAUMA)	Test group (n=23)		Controls (n=23)		$F(1,46)$	p	η_p^2	Welch's test of equality	
Variable	M	SD	M	SD				df 2	p
RT	730,7	78,3	729,8	79,3	0.002	.969	.000		
EC	31,5	26,4	34,2	36,8	0.079	.780	.002	39.9	.780
IIV	153,4	42,8	145,8	27,7	0.500	.483	.011		
Study 2 (CFS)	Test group (n=20)		Controls (n=33)		$F(1,54)$	p			
Variable	M	SD	M	SD					
RT	765,7	185,0	765,8	155,9	0.000	1.0	.000		
EC	20,2	42,7	32,12	38,49	1.18	.282	.021		
IIV	166,5	39,9	177,6	61,0	0.576	.451	.011		
Congruent CAE	-8,4	38,9	-30,0	46,8	3.257	.077	.057		
Study 3 (RAN)	Test group (n=23)		Controls (n=21)		$F(1,42)$	p			
Variable	M	SD	M	SD					
RT	673,4	73,9	660,9	55,5	0.393	.534	.009		
EC	46,8	32,5	43,1	29,1	0.162	.690	.004		
IIV	119,1	21,4	113,7	21,9	0.657	.422	.015		
Note. ** $p < .01$, * $p < .05$. Welch robust test of equality of means are reported for emotional conflict in study 1, due to violation on the assumption of homogeneity of variance (Levene statistic; $F(1, 44) = 4,14$, $p = .048$).									

Table 4. Group differences on variables using pooled controls, entering age as covariate.

Study 1 (TRAUMA)		Test group (n=22)		Controls (n=77)		<i>F</i> (1,95)	<i>p</i>	η_p^2
Variable		M	SD	M	SD			
RT		736,7	74,5	728,5	122,0	0.305	.582	.003
EC		31,7	27,0	35,2	35,5	0.305	.582	.003
IIV		155	43,1	151,4	51,6	0.481	.490	.005
Study 2 (CFS)		Test group (n=20)		Controls (n=77)		<i>F</i> (1,93)	<i>p</i>	
Variable		M	SD	M	SD			
RT		767,3	193,9	728,5	122,0	0.000	.989	.000
EC		19,9	44,7	35,2	35,5	1.157	.285	.012
IIV		166,5	41,7	151,4	51,6	0.166	.685	.002
Study 3 (RAN)		Test group (n=23)		Controls (n=77)		<i>F</i> (1,96)	<i>p</i>	
Variable		M	SD	M	SD			
RT		673,4	73,9	728,5	122,0	0.264	.608	.003
EC		46,8	32,5	35,2	35,5	0.268	.606	.003
IIV		119,1	21,4	151,4	51,6	0.256	.614	.003

Note. ** $p < .01$, * $p < .05$.
Participants with missing age-data were excluded.

3.3 Age and task variables

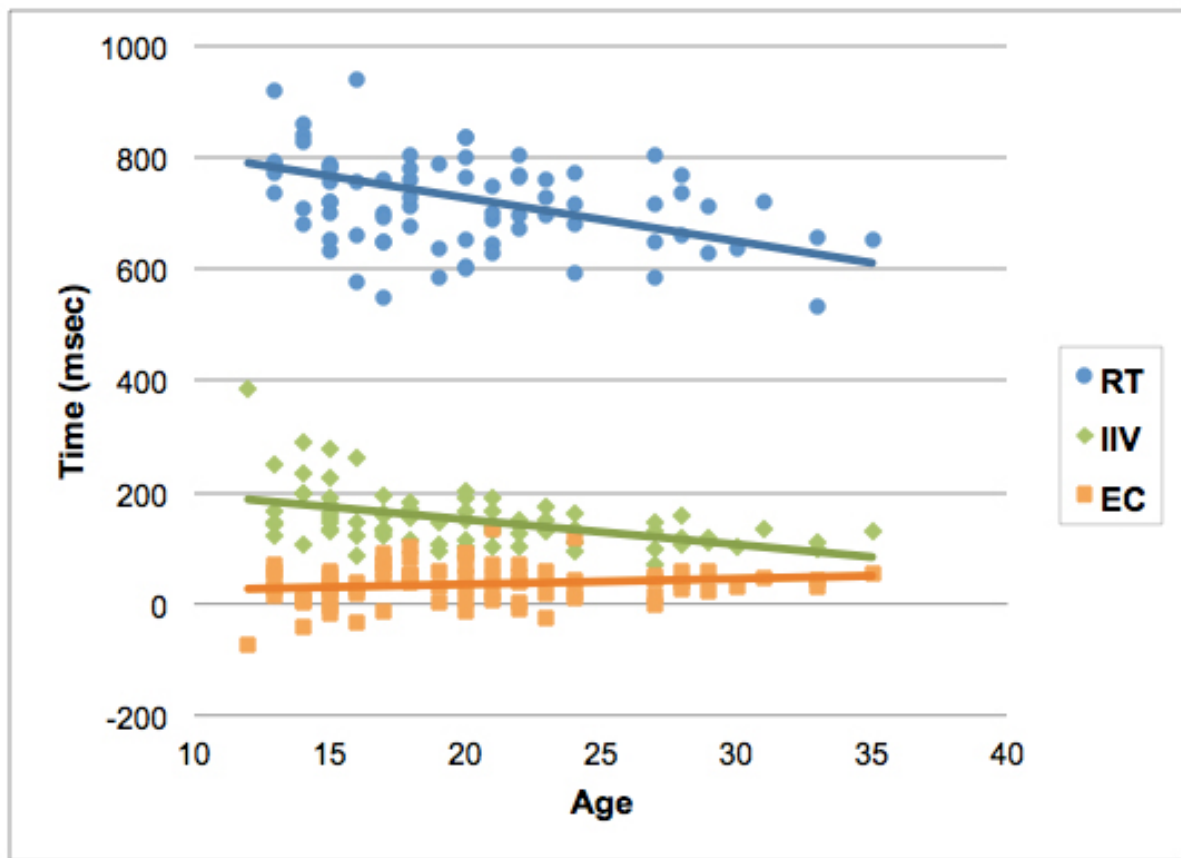
To examine age-related differences on task performance within controls, study was entered as factor to compare age groups (1: young adolescents, 2: old adolescents and 3: adults) in a one-way ANOVA. Significant group differences emerged for RT and IIV but not for EC (see table 6). Post-hoc comparisons revealed that RT for the young adolescents was significantly higher than for adults ($p = .005$), but not significantly different compared to older adolescents. Old adolescents and adults were not significantly different from each other on RT either. IIV differed significantly when comparing young adolescents to old adolescents ($p = .027$) and adults ($p = .000$), but old adolescents and adults did not differ significantly (although marginally not so; $p = .051$) on IIV.

Table 5. Group differences on task variables between (1) young adolescents, (2) old adolescents and (3) adults.

										Tukey HSD post-hoc tests (<i>p</i>)		
Age group	1 (n=34)		2 (n=23)		3 (n=21)		<i>F</i> (2,75)	<i>p</i>	η_p^2	1/2	1/3	2/3
	15,2±1,7		21,6±3,1		26±4,7							
Variable	M	SD	M	SD	M	SD						
RT	766	156	730	79	661	55	5.348	.007**	.125	.485	.126	.005**
EC	32	38	34	37	43	29	0.640	.530	.017	.975	.514	.688
IIV	178	61	146	28	114	22	13.52	.000**	.265	.027*	.000**	.051

Note. ** $p < .01$, * $p < .05$.
Participants with missing age-data were excluded.
Welch robust test of equality of means are reported for EC in study 1, due to violation of the assumption of homogeneity of variance (Levene statistic; $F(2, 75) = 7.7$, $p = .001$).

Figure 1. Relations between age and variables in the pooled control group.



3.4 Effects of emotion

In order to test potential effects of emotion (facial expression), a factorial 2 (fearful versus happy face) x 2 (congruent versus incongruent) repeated measures (MANCOVA) was performed, entering age as covariate. This analysis was first performed on the pooled control-group in order to test whether Etkin et al.'s (2006) finding on healthy participants (no effects of emotion) could be replicated with younger participants.

The main effect of facial expression was not significant (albeit close) for healthy controls (see table 7). A highly significant interaction between face and congruency emerged however ($p = .010$) (figure 2 A), as well as a significant three-way interaction between face, congruency and age ($p = .028$). In order to aid interpretation of the three-way interaction, EC was calculated separately for all trials with fearful faces (incongruent trials with fearful face – congruent trials with fearful face) and happy faces (incongruent trials with happy face – congruent trials with happy face). Age and EC Fear/EC Happy relations could then be interpreted by visual inspection of a scatterplot (figure 2 B), revealing that EC Fear increased

with age, whereas EC Happy remained relatively stable in comparison. To break it down further, plots were also made separately for interactions between age and incongruent/congruent conditions respectively (figure 2 C and D). These plots indicated that the observed tree-way interaction primarily related to incongruent trials; the youngest participants took longer to respond to incongruent trials with a happy face over incongruent trials with a fearful face. The opposite pattern was present for the oldest participants.

The same analysis was then performed for the pooled test-group, revealing somewhat different results. A highly significant main effect of facial expression emerged ($p = .014$), deviating from findings in the control group. Further, a highly significant interactions were found for face and age ($p = .006$), as well as congruency and age ($p = .009$), also deviating from findings with pooled controls. Visual inspections of the main effect of face in a bar graph indicated overall longer RT on Happy face trials over Fearful face trials. Furthermore, a scatterplot of age in relation to facial expression indicated that the youngest participants took longer to respond in happy face trials compared to fearful face trials. The opposite was true for the oldest participants (figure 3). Also deviating from the control-group was the non-significant interaction between facial expression and congruency as well as no three-way interaction between face, congruency and age. In fact, the only result shared by the pooled test group and the pooled control group was that congruency was non-significant, most likely due to the presence of several interaction effects.

Table 7. A 2 x 2 (facial expression x congruency), factorial repeated measures with age as covariate, performed on pooled control group and the pooled test group respectively.

Effect	Pooled controls (n=78)			Pooled test group (n=66)		
	<i>F</i> (1, 75)	(<i>p</i>)	η_p^2	<i>F</i> (1,63)	(<i>p</i>)	η_p^2
Face	3.527	.064	.045	6.436	.014*	.093
Face*Age	3.379	.070	.043	8.031	.006**	.113
Congruency	1.114	.295	.015	.373	.544	.006
Congruency * Age	1.687	.198	.022	7.170	.009**	.102
Face * Congruency	7.079	.010**	.086	1.670	.201	.026
Face * Congruency * Age	5.045	.028*	.063	1.110	.296	.017
Note. ** $p < .01$, * $p < .05$.						

Figure 2. **A:** Face, congruency interaction for the pooled control group. **B:** EC Fear and EC Happy in relation to age. **C:** Fear versus happy incongruent trials and age relations. **D:** Fear versus happy congruent trials and age relations.

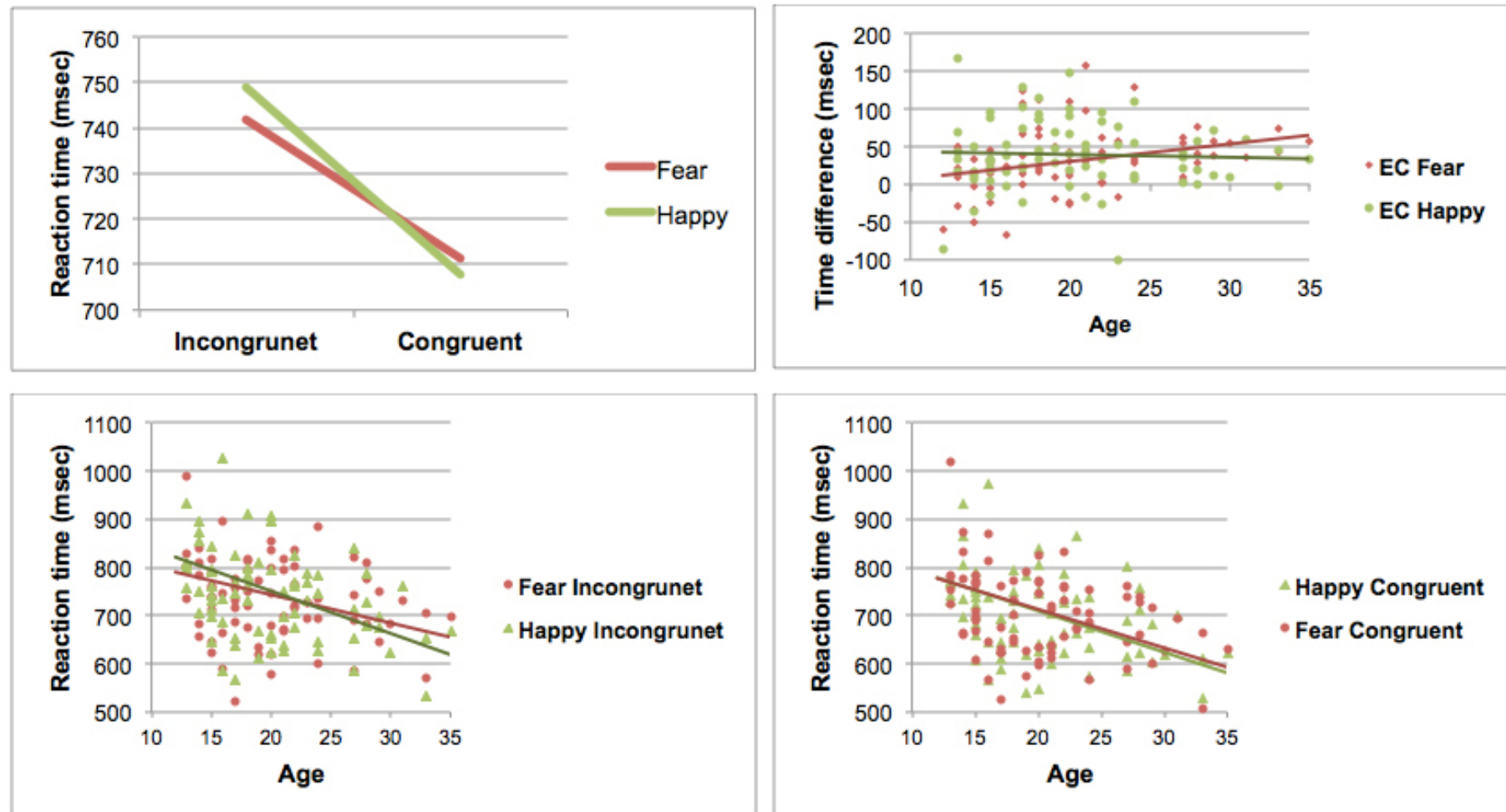
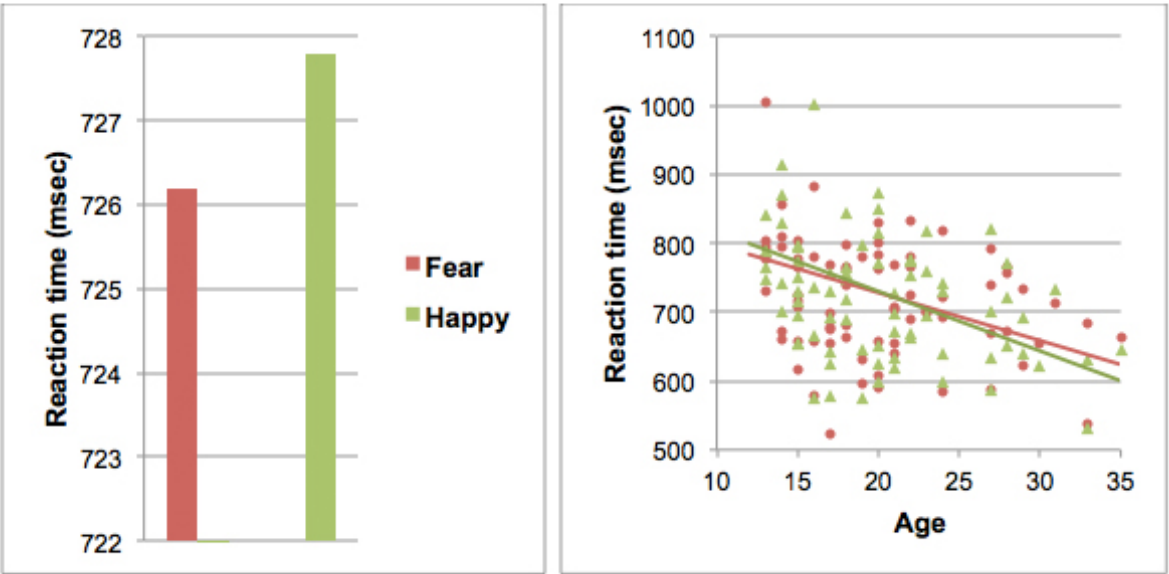


Figure 3. A: Main effect of face in the pooled test group. **B:** Interaction between age and facial expression in the pooled test group.



4 Discussion

In a broad exploration of the emotional conflict task, the current analysis investigated group differences, age-related changes and effects of emotion in participants across three separate clinical studies. Contrary to expectations, results revealed no group differences between test groups and healthy controls, and CAE did not consistently manifest across studies. However, task performance improved with age, revealed by group differences in RT between adults and old adolescents, and IIV differing between the young adolescents compared to both older adolescents and adults.

Furthermore, a significant interaction effect between facial expression and congruency, and a three-way interaction between facial expression, congruency and age, emerged for the pooled control group, indicating an effect of emotion modulated by age. Results for the pooled test group deviated from this, exhibiting a main effect of facial expression, interactions between age and facial expression and between age and congruency.

4.1 Group differences

The complete absence of group differences on RT, EC and IIV in the current study is somewhat surprising and at odds with earlier findings on cognitive impairment and emotion regulation difficulties in PTSD, AN and CFS. The task is thought to reflect top-down regulatory control during processing of emotional stimuli, and studies have indicated cognitive impairment related to interference in PTSD (Kertzman et al., 2014), cognitive flexibility in AN (Roberts et al., 2007) and processing speed in CFS (Cockshell & Mathias, 2013). These difficulties could be expected to influence regulatory control of emotion. In what way and whether the current task is able to measure this on a behavioural level in these disorders remains less clear.

Interestingly, Etkin & Scatzberg (2011) found no differences on a behavioural level, but compensatory brain activation for depressed participants in a study comparing three clinical groups and healthy controls using this task. Group differences on incongruent CAE (behavioural level) emerged in (1) anxiety and (2) comorbid anxiety and depression compared to healthy controls, but not in the (3) depression-alone group. However, similar patterns of hypo activation in ventral PFC (related to top down control in implicit emotion regulation (Ochsner & Gross, 2008)) and hyper activation in emotion generative regions in amygdala were found across all three clinical groups compared to controls. Furthermore, the

depressed-only group also showed hyper-activation in anterior lateral prefrontal cortex, being the only group with this pattern. Hence, the authors argue that this hyper-activation reflects compensatory activation, making depressed-only patients perform at equal level to healthy controls, in spite of a shared dysfunction with the anxiety and comorbid anxiety/depression patients (Etkin & Schatzberg, 2011). In a similar fashion, dysfunction might be present in PTSD, CFS and AN, albeit compensated for. This remains highly speculative however, since no analysis of data revealing brain activation is provided in the current analysis. In order to investigate possibilities of compensatory activation, analysis of brain images in conjunction with behavioural data should be examined for these clinical groups. Further, it could be argued that differences identified using imaging data have a stronger stand when supported by findings on a behavioural level, and interpretation of compensatory activation should be made with caution.

Perhaps more likely than compensatory efforts, the current finding could relate to the composition of test-groups in the current study. In the first study, only 21,7 % (N=5) of participants in the test-group actually met criteria for PTSD diagnose. This might explain lack of group differences when comparing this group to healthy controls. Comparing PTSD patients to trauma-exposed participants without PTSD as well as healthy controls allows for some interpretation with regards to disorder related versus trauma-related associations as well as predisposing factors (Iacoviello et al., 2014). Combining trauma exposed with and without PTSD in one test group on the other hand could rather preclude findings by creating a large within-group variation for the test group. Unfortunately, the current trauma study did not have a large enough N to provide a division into three groups. Hence, the test group contained a large variation, with the majority of participants not reaching clinical status.

This issue of diagnostic status in the test group might have been even more pronounced in the AN study where no participants met diagnostic criteria since they were all recovered. Studying recovered AN participants rather than individuals during an acute episode makes sense, given that starvation itself might influence EF (Lozano-Serra et al., 2014; Uher et al., 2003) and implicit emotion regulation. The current results seems to indicate that implicit emotion regulation difficulties in AN does not persist after recovery. This is in concordance with an earlier study finding emotion regulation to remit after recovery (Harrison et al., 2010). However, Harrison et al.'s finding on emotion regulation was based on self-report questionnaires, hence the current finding calls for replication. Furthermore,

whether the task would tap implicit emotion regulation difficulties in AN during acute episodes remains unanswered.

In fact, the CFS group was the only clinical group proper in the current study, with all participants meeting diagnostic criteria. However, this group represents the diagnosis for which documentation and theoretical explanations with regards to emotion regulation difficulties as well as cognitive impairment is the most lacking. The absence of a group difference between the CFS test-group and healthy controls may therefore not be particularly informative with regards to the tasks ability to tap implicit emotion regulation difficulties in clinical populations. In addition, the CFS study had the youngest participants. A fair proportion of these participants might not have reached the age/developmental stage where deviations due to normative development are easily separated from deviations due to clinical conditions. Differences between healthy and clinical groups tend to be harder to detect at a younger age, due to the inherently large variance found in younger populations compared to adults.

In sum, lack of group differences on RT, EC and IIV could relate to the composition of test-groups, given that only one of the test groups actually contained a clinical sample proper. Hence, implicit emotion regulation difficulties might be an important factor in PTSD and AN, and the current task might be a valid measure of such difficulties in these disorders, in spite of the current results.

4.2 CAE

The surprising finding that CAE did not emerge consistently across studies might pose a bigger challenge to the current paradigm. In fact, none of the CAE effects appeared for the control group in study 1 and 3 and only congruent CAE appeared in the control group of study 2. Given the prominent role of incongruent CAE in literature on implicit emotion regulation based on the current task, this is somewhat problematic. The paradigm is based on, and designed for, identifying differences in CAE when comparing clinical population to healthy controls. Specifically: CAE is expected to be measurable for healthy individuals and be impaired (hence not measurable) for clinical populations for whom emotional regulatory control is thought to be an issue. Yet, in the current study the effect failed to emerge at all within several healthy control groups as well as in the pooled control group. Age might provide a potential explanation, given that two of the studies represent fairly young

participant. CAE is thought to reflect top down control in implicit emotion regulation (Carter & van Veen, 2007; Egner & Hirsch, 2005b; Gyurak, Gross, & Etkin, 2011), dependent on frontal regions not fully matured until late adolescence/early adulthood (Sowell et al., 2004; Yurgelun-Todd, 2007). If regions underlying successful adaptation to conflict are not fully matured, this could explain that the effect was not measurable in the current study. However, congruent CAE emerged in the CFS study's control group (young adolescents), while not appearing in the control group of the TRAUMA study (older adolescents) or the RAN study (adults), contradicting such an explanation.

An important factor potentially influencing the presence of CAE in the current study must be mentioned. Due to an unforeseen programming error, the CAE conditions (iC, iI, cC and cI) were not equally balanced in two of the studies (TRAUMA and CFS) using the exact same paradigm. This error could reduce the tasks ability to pick up the effect. However, the third study (RAN) was properly balanced, and CAE did not emerge here either. Furthermore, the effect did not consistently manifest in the considerably larger pooled control group (N=148) (only congruent CAE emerged) either, calling for some consideration of the stability and utility of the CAE in this paradigm.

Importantly, the literature on CAE, relating the effect to the conflict monitoring hypothesis, tend to emphasise incongruent CAE, while remaining relatively silent about the effect of congruent CAE, providing little or no theoretical explanation for the latter. Yet, in the current study, only congruent CAE emerged at all. If incongruent trials boost attentional control aiding conflict resolution in the following trial, how does that relate to congruent CAE, and the relationship between incongruent and congruent CAE? What is actually boosted during conflict adaptation? Imaging studies have shown that cognitive control mechanisms enhance performance by amplifying cortical responses to task-relevant information, rather than inhibiting processing of task-irrelevant stimuli (Chechko, Kellermann, Schneider, & Habel, 2013; Egner & Hirsch, 2005a). Hence, congruent trials following incongruent trials should equally benefit from such a boost. At odds with this notion, is that the difference between iC (slow congruent) and cC (fast congruent) was larger than cI (slow incongruent) and iI (fast incongruent) in the current study. This is surprising, given that it is the slow congruent and the fast incongruent trials that receives a "boost" following an incongruent trial. In other words, according to the basic notion of incongruence in the previous trial boosting attention to task relevant stimuli on the following trial, incongruent CAE should be larger (hence more robust and detectable) than congruent CAE. Yet, in the current study, only congruent CAE emerged at all.

There seems to be some inconsistencies concerning congruent CAE across some of the studies reported by Etkin and colleagues as well (Egner et al., 2008; Etkin et al., 2010; Etkin et al., 2006). In the first article presenting the paradigm, the task was tested on a healthy sample (N=19) in order to investigate the neural correlates of emotional processing and conflict resolution (Etkin et al., 2006). In this study congruent CAE did not emerge (according to the graphic presentation in the article, numbers were not reported). In a follow-up study, aiming to separate neural substrates underpinning emotional conflict resolution versus cognitive conflict resolution (with congruent/incongruent sex-labels superimposed on the images, rather than emotional words) nothing is reported regarding congruent CAE (Egner et al., 2008). Then, in the first clinical study using the paradigm, comparing GAD patients to healthy controls, congruent CAE surfaces and is presented as control-condition. Specifically, congruent CAE is reported proper for the first time, and is argued as evidence for the specificity of the group difference in the incongruent CAE, since no group differences emerged for the congruent CAE (Etkin et al., 2011). This inconsistency, and the fact that it is not addressed seem problematic and could propose a challenge to the notion of CAE as a reliable construct. A better understanding of the mechanisms behind both incongruent and congruent CAE seems therefore warranted, particularly in light of the current results indicating the presence of congruent CAE only.

Issues concerning the stability and utility of CAE and composition of test groups taken together, perhaps a more informative approach for combining data across these studies is to examine normative development utilising other variables of the task in healthy controls.

4.3 Age and task variables

The stroop task depends on frontal lobe regions (Botvinick, Cohen & Carter, 2004; Carter & van Veen, 2007; Fan, Flombaum, McCandliss, Thomas & Posner, 2002; Ridderinkhof, van den Wildenberg, Segalowitz & Carter, 2004) and maturation in these regions stretch into late adolescence/early adulthood (Casey et al., 2010; Paus, 2005; Perlman & Pelphrey, 2011; Steinberg, 2005). Accordingly, earlier studies investigating the Stroop CW task in relation to development, have found performance on this task to improve with age (Adleman et al., 2002; Daniel, Pelotte & Lewis, 2000; Schroeter, Zysset, Wahl & von Cramon, 2004). Results in the current study based on an emotional stroop task, are in accordance with this, extending earlier findings to the domain of cognition-emotion interaction. For instance, RT differed significantly between old adolescents and adults, with response time decreasing with age. Furthermore, young adolescents differed significantly

from old adolescent and adults on IIV, indicating that also stability in performance increased with age. However, no differences between age groups were found for EC in the current study. This appears to be at odds with the literature on increased efficiency in regulatory control dependent on frontal lobe maturation. For instance, Schroeter et al. (2004) found that RT as well as interference control improved with age on the Stroop CW task. Furthermore, interference related activation increased with age in the dorsolateral prefrontal cortex, correlating with improved performance. A potential explanation for this discrepancy is that Schroeter et al. compared children (7-13) to young adults (19-29), potentially picking up differences not present between groups of higher age like adolescents and adults. The functionality of detecting and resolving conflict may be more or less in place by mid-adolescence, developed to a point where detection of relatively small differences amongst the age groups in the current study demands larger samples.

It has been suggested that the stroop task may depend on several regions (e.g., parietal and frontal regions) with somewhat different developmental trajectories, so that some variables derived from the task will correspond differently with age, at different developmental stages (Adelman et al., 2002). Hence, differences in performance between children, young adolescents, old adolescents and adults might deviate differently dependent on what variable derived from the task is being analysed. Thus, in a developmental perspective, investigating a range of variables might prove particularly informative. Interestingly, the far less utilised measure of IIV provided the most robust findings on age-related differences and came very close to a significant group difference between all three age groups. Earlier research have found IIV to represent a U-shape throughout the life-span; showing high levels in children and young adolescents, a drop during young, middle and older adults, in order to increase again in old age (Williams et al., 2005). This U-shape is proposed to co-occur with developmental changes in grey- and white matter, primarily in the frontal lobes, indicating that IIV reflects functionality within this region (Gogtay & Thompson, 2010; Raz et al., 2004; Sowell et al., 2003, 2004). These relationships have primarily been proposed indirectly, across studies. Nonetheless, it seems plausible that IIV taps functionality related to attentional processes, located in the frontal lobes. Furthermore, some authors argue that IIV might in fact provide information not equally well detected by central tendency-data like mean RT and accuracy (Hervey et al., 2006b). This is because IIV picks up on attentional lapses giving significantly longer RT's on a few trials, while obscuring central tendency data disproportionately. In fact, IIV provided the most robust measure of age related changes in the current study using the emotional conflict task,

indicating its potential usefulness when investigating implicit emotion regulation in development. So far, most studies utilising IIV, have investigated attention in ADHD, brain lesions, dementia and schizophrenia (MacDonald et al., 2006). However, IIV has also been related to negative affectivity in healthy college undergraduates (Ode et al., 2011). Given findings in the current study utilising IIV in an implicit emotion regulation task, expanding its use to a wider spectrum of mental disorders seems promising. More specifically, findings suggest that IIV could be relevant for investigation of disorders where emotion regulation difficulties are typically implied. Furthermore, combining clinical and developmental research on IIV could prove informative in relation to vulnerability in general as well as vulnerable periods during development. Considering the heightened reactivity and frequent onset of mental disorders during adolescence (Casey et al., 2010, 2008; Steinberg, 2005) and the current finding indicating that IIV taps age related changes in top down control of emotion during this developmental period, investigating IIV in adolescents, tracing its neural correlates, could prove particularly potent.

Although intriguing, the notion that different variables reflect task-demands in different regions remains highly speculative. Investigating this proposal demands direct comparisons between behavioural performance and imaging data, and the current thesis does not report on brain activation. However, future imaging-studies could investigate a broad array of variables derived from this task, exploring whether such an approach can shed light on different developmental trajectories and neural correlates of various task demands. Given the tasks emotional content and regulatory demands, it might inform current theory on different developmental trajectories of emotion generating and regulatory control regions causing reactivity in adolescents. To further understanding of how maturation of prefrontal regions and prefrontal-subcortical connections influence processing of emotional conflict and regulatory control, could shed light on vulnerability factors and guide interventions during this vulnerable period.

4.4 Effects of emotion

If the current paradigm is to be extended to research on development and new areas of clinical research, it is important to have a clear understanding of any effects the paradigm might be driving within these populations. According to Etkin et al. (2006) emotion did not drive any effects in the paradigm. However, this finding was reported based on a healthy, adult sample. Given the heightened reactivity observed in adolescents (Casey et al., 2010, 2008; Steinberg, 2005), young participants could process emotional stimuli like facial

expressions differently than older participants. In fact, findings from the current study indicate the presence of an age-related difference: facial expression and congruency interacted in the pooled control group, and this interaction was modulated by age. More specifically, EC for trials presenting a happy face seemed fairly stable across the entire age-span, whereas EC for trials presenting a fearful face increased with age. Earlier findings indicating that reactivity to fearful faces change with age might provide a clue (Gee et al., 2013). For instance, adolescence have been found to exhibit stronger activation in amygdala, bilateral orbitofrontal cortex, and anterior cingulate cortex (implicated in processing of emotionally salient information) during passive viewing of fearful faces compared to adults (Monk et al., 2003). How this activation maps on to behavioural performance and top down control during an emotional conflict task is less clear however. One interpretation of the current result is that attentional bias towards threat, facilitating the processing of fearful faces, aids conflict resolution on incongruent fearful trials for the younger, more reactive participants. Contrary to this, others have found fearful faces to increase interference in adolescents compared to adults (Ladouceur et al., 2009). However, this result was found in a task where emotional faces were included as mere distractors. According to the “dual competition” framework (Pessoa, 2009), attentional bias to threat can aid performance when the threatening stimuli is task relevant, whereas it might disrupt performance when task irrelevant. This notion reconciles the discrepancy of the current result and that of Ladouceur et al., since the emotional faces in the current task were task relevant. Furthermore, scatterplots of incongruent fear/happy trials in relation to age indicated that the youngest participants spent less time responding to incongruent fearful trials over incongruent happy trials. This could be interpreted as support for a target-facilitation notion. However, happy incongruent trials also contain a threat related distractor, namely the word “Fear”. Happy incongruent trials could therefore express longer RT’s as a result of this threat-related word capturing attention, slowing disengagement and response time in relation to the target (happy face). Unfortunately, since the current paradigm does not provide neutral conditions, valence of target versus distractor stimuli cannot be separated in order to interpret the observed effects. Nonetheless, the presence of an interaction effect between emotion and congruency remains an important finding. Furthermore, the fact that this effect was modulated by age in a healthy sample ranging from young adolescents to adults reveals that an important assumption for the current paradigm is not met when the task is used in this age-span. This could have implications for the use of the current task in developmental studies.

Interestingly, the pooled test group exhibited different results compared to the pooled control group when examining effects of emotion. A highly significant main effect of facial expression as well as a highly significant interaction between facial expression and age emerged in this group, but not in controls. Noteworthy, the authors of the paradigm have not reported whether any effects of emotion are present in clinical samples, but base this assumption on findings reported on a healthy sample only (Egner et al., 2008; Etkin et al., 2006; Etkin & Schatzberg, 2011). Earlier research has indicated that some clinical populations might process emotional stimuli differently compared to healthy individuals. For example, looking at findings from studies of PTSD and AN using emotional faces as stimuli point to potential problems regarding the use of such stimuli in the current paradigm. For instance, compromised functioning in emotion recognition have been found in AN using both facial stimuli and stimuli depicting eyes only (Harrison et al., 2010; Zonneville-Bender, Van Goozen, Cohen-Kettenis, Van Elburg & Van Engeland, 2004). Such impairment in emotion recognition could influence results (e.g., processing speed and conflict resolution) in the current paradigm. Accuracy-data could have provided clues to whether emotion recognition difficulties were present for RAN participants. However, since accuracy data were not included in the current analysis, effects related to emotion recognition impairment in the AN test group, potentially influencing results, cannot be ruled out.

With regards to PTSD, emotional stimuli have frequently been used in order to investigate the role of attentional bias in this disorder. Several studies have indicated attentional bias towards threat in PTSD (Bar-Haim et al., 2007; Bardeen & Orcutt, 2011; Bryant & Harvey, 1997; Fleurkens et al., 2011), and the notion of hyper vigilance towards threat holds a prominent place in theory on development and maintenance of PTSD (Brewin & Holmes, 2003; Cisler et al., 2011, Constans, 2005). This is relevant to the current discussion since attentional bias to threat could influence results, given the use of emotional stimuli. How such a bias would influence results is hard to predict however, given inconsistencies and gaps in the literature on attentional bias in PTSD (Buckley, Blanchard & Neill, 2000; Cisler et al., 2011; Hauschildt, Wittekind, Moritz, Kellner & Jelinek, 2013; Kimble, Frueh & Marks, 2009). For instance; several paradigms (like the traditional emotional stroop for instance) are lacking in providing information on *how* AB drives effects; facilitating detection of threat or increasing interference (problems disengaging from threat stimuli) (Pineles, Shipherd, Mostoufi, Abramovitz & Yovel, 2009). Furthermore, AB in terms of avoidance of threat, rather than vigilance towards it, have also been found in PTSD (Bar-Haim et al., 2010; Pine et al., 2005; Schoorl et al., 2014). Hence, there seems to be two

opposing tendencies in PTSD attentional bias; “vigilance towards” versus “avoidance of” in response to threat. Furthermore, most studies do not attempt to detangle these opposite tendencies (Iacoviello et al., 2014). This is highly problematic since vigilance towards threat could produce shorter RT’s while avoidance could produce longer RT’s, meaning that effects might go undetected in studies owing attention to only one tendency. Examining IIV in PTSD has been proposed as a potential way out of this caveat, since fluctuation between vigilance and avoidance should manifest in higher IIV (Iacoviello et al., 2014). In fact, Iacoviello et al., found IIV to differ significantly between their three participant groups; (1) PTSD, (2) trauma-exposed with no PTSD and (3) no trauma-exposed controls. They also found a significant, positive correlation between IIV and symptoms of PTSD. In the current study the PTSD test-group did not differ from healthy controls on IIV, indicating no attentional bias. However, this finding could relate to the composition of the test-group, leaving the question of whether attentional bias in patients with PTSD could influence results in the current paradigm.

In spite of questions regarding attentional bias and impaired emotion recognition remaining unanswered, the fact that effects observed for the pooled test-group deviated from findings in the pooled control group is important. Notably, this difference emerged when contrasting healthy controls to a test group where only 38,5% of the participants met diagnostic criteria. Group difference could potentially be more pronounced when comparing healthy individuals to clinical groups proper. Due to several factors (e.g., group composition, age span and different diagnoses), results for the pooled test group are somewhat hard to interpret in relation to theory and earlier research on emotional stimuli processing within various disorders. Nonetheless, the current finding indicates that processing of emotional faces in this paradigm might differ between clinical populations and healthy controls, questioning a basic assumption in the paradigm. Whether a violation of this assumption has impact on the validity of the measure should therefore be investigated. Furthermore, this issue might be more pronounced with regards to developmental research, since the main effect of emotion interacted with age. This notion is supported by findings from a study comparing anxious to non-anxious children, adolescent and adults on an emotional N-back task (Ladouceur et al., 2009). Results revealed that fearful faces influenced performance in anxious individuals. Furthermore, this interference interacted with age, with adolescents showing more interference than adults. Hence, effects like attentional bias and interference found in clinical disorders might be even more pronounced for younger individuals.

In sum, effects of emotion seem to be operating within the current paradigm. Importantly, these effects varied between the pooled test group and the pooled control group, indicating that some effects of emotion are also related to clinical status. Equally important, all observed effects were modulated with age. Thus, in order to fully take advantage of the current emotional conflict task, effects of emotion should be investigated and accounted for in healthy as well as clinical groups across different developmental stages.

5 Limitations, future directions and concluding remarks

The current study combined data from three different research projects in order to investigate effects related to age and clinical diagnose in an emotional conflict task. The strength of this approach is that it could provide a relatively broad exploration of the task. Performance was compared on several variables across clinical diagnoses not previously investigated with this task and pooling controls across studies allowed for a novel examination of task performance in normative development.

However, some limitations follow suit with the approach of pooling data across studies. For one, participants were recruited within the framework of three different projects, potentially leading to initial selection differences. For instance, the composition of test-groups varied across studies in terms of degree of severity (number of test-group participants reaching clinical status). This could lie behind the observed lack of group differences, clouding interpretation with regards to the tasks ability to capture underlying deficiency across clinical borders and disorder specific expressions of such deficiency. Future studies should aim for clinical groups proper when investigating the task as candidate for standardised measure crossing clinical boundaries. Another important limitation related to this approach is the systematic co-variation of age and clinical disorder as a result of different studies targeting different age groups. In an attempt to trace small effects and avoid a type II error, each test group was compared to the pooled control group, while controlling for age (ANCOVA). However, covariates that vary systematically with experimental effect are problematic (Field, 2013, s. 484). Such a covariate will not necessarily remove confounds, since removing variance associated with the covariate potentially alters the dependent variable as well. Thus, using a covariate is primarily recommended in experiments with random assignment (Miller & Chapman, 2001). In the current study, age co-varied systematically with 1) type of diagnose and 2) diagnose severity, compromising analysis when comparing individual test-groups to the pooled control group. Consequently, caution is called for when interpreting these results.

Additionally, the balance of male and female participants was not equal across studies. However, preliminary analysis revealed no differences related to sex on any variables in study 2 (having an even distribution of male and female participants), so results were most likely not influenced by the uneven distribution of sex across studies. Nevertheless, future studies aiming to compare results across various clinical disorders on the emotional conflict task should aim for more homogenous groups with regards to sex as well as age and severity.

One last limitation related to pooling data across studies in this specific case deserves mentioning, namely the fact that the paradigm was not completely identical in terms of stimuli presentation across all three studies. The exact same programming of the paradigm was implemented for study 1 and 2, and this programming deviated from the original design (Etkin et al., 2006) in one potentially important way. As a result of randomisation across the four conditions, the design was not balanced in relation to the conflict adaptation effect. More specifically, there were 30 cC, 53 iC, 54 cI and 30 iI trials, as opposed to equal numbers in the version by Etkin et al. (2006). Study 3 on the other hand was properly balanced, and the fact that CAE appeared in study 2 and not in study 3 therefore indicates that the tasks ability to measure CAE in study 1 and 2, were not necessarily a result of this coding error. Thus, combining data across studies in the pooled control group most likely provide valid information with regards to the potential utility and stability of the CAE.

Some potentially informative variables were not subjected to analysis due to the relatively broad exploration approach in combination with the limited scope of this paper, and these deserve mentioning. For one, accuracy data were not analysed, but could have provided additional information, particularly with regards to impairment in emotion recognition related to age and/or clinical diagnose. For instance, a meta-analysis of 9 emotion recognition studies concluded with impairment in emotion recognition in AN, arguing this difficulty to be trait-like (Oldershaw et al., 2011). Such impairment could influence reaction time data in the current task. Accuracy data should therefore be addressed in future studies using this task to investigate implicit emotion regulation in AN to clarify how emotion recognition ability might influence performance on this task. Furthermore, several studies have indicated that the ability to recognize emotional expression in others improve with age (Kolb, Wilson, & Taylor, 1992; Thomas et al., 2001). Thus, future developmental studies using the current task should also include analysis of accuracy data. Second, upon investigating effects of emotional content, analyses were based on emotional faces only. Effects of emotional words were not analysed and the question of valence in incongruent trials remain highly illusive. Effect of emotional words should therefore be investigated as well, and effects of faces and words should be separated. Unfortunately, several factors in the paradigm complicate such an investigation. For instance, no neutral condition is presently included, complicating attempts to investigate effects related to valence. Furthermore, effects of emotion stemming from facial expressions and/or words cannot be detangled in the current design, since all trials consists of both. Perhaps instinct-based processing of facial

expressions could be expected to have prominence over a learned process like reading, suggesting that effects of emotions are driven by facial expression rather than words. Moreover, the task is to focus and respond to the face, not the word. However, words have been shown to produce much larger interference effects (attending to the face while ignoring the word) compared to faces (attending to the word while ignoring the face), indicating that automatic reading is more intrusive to processing of facial images, than the other way around (Ovaysikia, Tahir, Chan & DeSouza, 2011). If this is the case, observed effects could relate to words rather than to faces. Thus, in order to fully understand the workings of emotional content in this task, neutral conditions to investigate valence and separate effects of word from facial expression would have to be implemented and explored.

Future studies should therefore attempt to clarify these issues by including neutral conditions, examining healthy and clinical populations spanning across a wide age-span. Furthermore, to clarify issues concerning attentional bias, the current emotional conflict task could be combined with other task, more apt to investigate over-engagement versus difficulties with disengagement (e.g., the emotional spatial cuing task) and bias towards versus avoidance of threat (e.g., the dot-probe task) (Ladouceur et al., 2009). Such an approach could help to create a broader picture of how automatic attention and regulatory control interact during the processing of emotionally salient stimuli.

Importantly, the validity of the CAE construct should be further investigated, and more attention should be diverted towards congruent CAE and the differences as well as similarities in these two adaptation effects. Furthermore, given the current study's indication that IIV is somewhat more robust than other variables in relation to age differences, further examination of IIV in this task should be undertaken as well. Such exploration should be provided in tandem with imaging data in order to trace the neural correlates of IIV and other variables, to further understanding of how maturation of the prefrontal regions influence processing of emotional stimuli and regulatory control. Such an approach could also benefit from longitudinal research, mapping different developmental trajectories in maturation of frontal lobe and emotion generative areas, as well as prefrontal-subcortical connectivity. This could help to advance current understanding of vulnerability in development, targeting treatment and interventions.

Future studies should also try to combine the current task with measures of explicit emotion regulation. This might aid integration of the ever-expanding research field of

emotion regulation, providing a broader understanding of cognition and emotion interaction related to the habitual use of maladaptive/adaptive strategies as well as ability.

To conclude; contrary to predictions, no group differences related to clinical diagnose were found. However, this could relate to the composition of test-groups rather than the tasks ability to tap difficulties with implicit emotion regulation across a spectrum of disorders, including PTSD, CFS and AN. Age was found to relate to performance on several variables derived from the task, including the less utilised measure of IIV, indicating the tasks potential in developmental research. Importantly, the current study raises some concerns with regards to the validity and utility of the CAE construct in this task, which it is primarily designed for. Furthermore, effects of emotion within the current paradigm were investigated with regards to age and clinical status for the first time. Results indicated the presence of emotion effects modulated by age and deviating between the pooled test group and the pooled control group. Whether these issues challenge the overall validity of the task needs to be addressed and clarified in future studies, particularly if the task is to be used in research on a broader spectre of disorders and/or in developmental research.

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